

SCIENCE

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JAMES EDWARD KEELER.

THE sudden death of Professor James E. Keeler, Director of the Lick Observatory, which occurred at San Francisco on August 12th, removes one who stood at the very

forefront of astrophysical research. The advanced position occupied by the United States in the development of astrophysics is due as much to Keeler as to any other individual. The high quality of his own investigations, and the effect of his example on the work of others, have been factors of the first importance in building up the physical side of astronomy in this country. The shock caused by his wholly unexpected death has been felt by many, not least by some of those whose friendship for him grew out of a common interest in his own field of science.

As he was still in his forty-third year, and had until recently enjoyed the best of health, there seemed to be every reason to expect that his important contributions to astrophysical literature would continue for many years to come. But a severe cold, contracted in the course of his recent work with the Crossley reflector, developed into pneumonia, which was complicated with heart trouble. From the accounts which have so far reached us it appears that he withstood this first illness, and had just entered a hospital in San Francisco, when he was seized with an apoplectic stroke from which he did not rally.

James Edward Keeler was born at La Salle, Illinois, on September 8, 1857. As a boy he was greatly interested in science, and I have often heard him speak of his early chemical experiments and astronom-

ical observations made with instruments of his own construction. His father, who was a paymaster in the navy, served with distinction in the civil war, and was on board the *Monitor* during her memorable fight with the *Merrimac*. Keeler's qualifications for scientific work clearly showed themselves at the Johns Hopkins University, where he took an undergraduate course, and served as assistant to Professor Hastings, with whom he observed the total solar eclipse of 1878 in Colorado. His report on the eclipse, which is accompanied by a drawing of the corona, is a characteristically clear and concise paper.

Shortly after this he was appointed assistant at the Allegheny Observatory, where he had an important part in the long series of bolometric investigations carried on by Professor Langley, then Director of the Observatory. In July, 1881, he was a member of Professor Langley's well-known expedition to Mount Whitney, in Southern California, where an extensive region in the extreme infra-red of the solar spectrum was discovered with the bolometer.* Later he studied for two years in Berlin and Heidelberg under Helmholtz and Quincke, and returned to the Allegheny Observatory, where he remained until appointed a member of the staff of the Lick Observatory. His work on Mt. Hamilton commenced in 1886, and for some time he was the only astronomer at the Observatory, which was still in process of construction. In May, 1891, he was elected Professor of Astrophysics in the Western University of Pennsylvania and Director of the Allegheny Observatory. In June of the same year he married Miss Matthews, a niece of Captain Floyd, President of the Lick Trust, with whose family she had lived on Mt. Hamilton.

Keeler's work at the Lick Observatory, of which more will be said in what follows,

* A peak in the Mt. Whitney range was named 'Keeler's Needle.'

was continued in a most effective manner with the modest instrumental resources at Allegheny. His work here might well serve as an object lesson to those who complain of their inability to obtain useful results because they do not happen to have instruments of the largest size at their disposal. With a full understanding of the art of making the most of his means, he took up photography for the first time, made himself thoroughly familiar with photographic processes, and then, with the aid of a spectrograph whose general design has been followed in the construction of the great modern spectrographs at Mt. Hamilton, Potsdam, Pulkowa and Williams Bay, he obtained the photographs of the spectra of red stars which excited so much interest at the dedication of the Yerkes Observatory. He also made an admirable series of drawings of Mars, which was published in the *Memoirs of the Royal Astronomical Society*. In 1893 he accompanied the writer on an astrophysical expedition to Pike's Peak, where his experience and assistance were invaluable. In the same year, in company with Professors Crew and Ames, he joined me in editing the astrophysical part of *Astronomy and Astrophysics*. The *Astrophysical Journal* was established in 1895, and Keeler became joint editor with myself of the new publication. Until his return to Mt. Hamilton in 1898, where distance prevented him from taking an active part in the editorial work, he gave much time to the Journal, which owes much to his labors.

Keeler's spectroscopic proof of the meteoric constitution of Saturn's rings was made at Allegheny in the spring of 1895. In October, 1895, at the writer's request, he made at Cambridgeport the tests of the 40-inch object-glass of the Yerkes telescope which led to its final acceptance. Two years later, at the dedication of the Yerkes Observatory, he delivered an excellent address 'On the Importance of Astrophysical

Research and the Relation of Astrophysics to other Physical Sciences.' In the spring of 1898 he had practically decided to accept a position on the staff of the Yerkes Observatory, and would have done so had he not just then been appointed Director of the Lick Observatory. Strenuous efforts were made by the citizens of Allegheny to retain him, and a project for a new Allegheny Observatory was set on foot by Dr. J. A. Brashear, who has since carried it to a successful conclusion, though at the time in question it was impossible to raise the necessary funds. At the Yerkes Observatory our regret in losing so able and genial a coadjutor was tempered by the feeling that the cause of science would undoubtedly be best advanced by placing such a man in charge of the great institution on Mt. Hamilton.

This view has been most amply justified by the recent work of the Lick Observatory, which has attained the highest degree of efficiency under Keeler's administration. The activity of the Observatory in various fields of research, and the uniform excellence of observations made by men working under the inspiration of able leadership, have been recognized by all who keep in touch with astronomical progress.

But Keeler's recent work on Mt. Hamilton has not been confined to the direction of the affairs of a great observatory. The remarkable success of his experiments with the Crossley reflector, of which a full account is fortunately preserved in the June number of the *Astrophysical Journal*, has impressed everyone who has seen the wonderful photographs of nebulae and star clusters made with this instrument. The record of this work, like that of many other events in Keeler's career, is full of instruction to those who aspire to achieve success as investigators. When entering upon his duties at Mt. Hamilton, Keeler called together the members of the staff to confer upon the obser-

vations to be undertaken. It is customary to divide the nights of the week with the great telescope among several observers, each of whom is pursuing a certain class of observations. When the division had been completed it was remarked with surprise—for the privilege of using such a telescope is highly valued—that Keeler had taken no nights for himself. On the contrary, instead of benefiting by the advantages which must have resulted from the use of the powerful and perfect refractor, he had chosen the difficult and rather uninviting task of bringing into use the Crossley reflector, an instrument of great optical power, but provided with a mounting of such design and construction as to render it almost unfit for exacting work. Although transferred from England to Mt. Hamilton several years before, no results had been obtained with this telescope in its new location. The reflector was best adapted optically for the photography of faint nebulae, but mechanically it was not adequate for such work which more than any other demands a mounting of the highest stability and perfection of detail. The story of how obstacle after obstacle was encountered and overcome is modestly told in the paper to which reference has been made. The resulting photographs of nebulae far surpass any similar photographs ever before obtained, and reveal new and unexpected features of the first importance. Hundreds of hitherto unknown nebulae were discovered on the plates, and from an examination of these a fact of great significance was established, viz: that the majority of the nebulae are spiral in form. It has long been known that certain of these cloud-like masses, from which the stars are supposed to be formed, show a spiral structure, but these were considered to be exceptions, and by no means type objects. As the result of Keeler's work it does not appear improbable that future theories of stellar evolution will

start from the spiral rather than from the sphere of La Place's nebular hypothesis.

Of Keeler's other contributions to science two in particular deserve present mention: his determination with the Lick telescope of the motion in the line of sight of the planetary nebulae and his demonstration of the meteoric constitution of Saturn's rings. The memoir which describes the first of these investigations already ranks as a classic of astrophysical literature. From the well-known principle of Doppler, the lines in the spectrum of a moving luminous object are displaced toward the violet or red according as the motion is directed toward or away from the observer. The spectrum of the planetary nebulae consists of a small number of bright lines, which under high dispersion are widely separated from one another, but not greatly weakened in intensity. Keeler was the first to take advantage of this fact by using in the powerful spectroscope, designed by himself for the Lick telescope, a closely ruled Rowland grating. With the great dispersion of the fourth order spectrum, he was able to measure the positions of the nebular lines with an accuracy far surpassing that attained in any previous observations of these faintly luminous objects. The resulting velocities of the nebulae in the line of sight were on the average considerably smaller than the extreme values, of which the greatest motion of approach was that of the nebula *G. C. 4373*, 40.2 miles per second, while the greatest motion of recession was 30.1 miles per second, for the nebula *N. G. C. 6790*. It was also found that the distance between the Great Nebula of Orion and the Sun is increasing at the rate of about 11.0 miles per second. On account of the thorough manner in which this research was planned, the skill exhibited in designing the spectroscope for the Lick telescope, the care taken in executing the measures and eliminating possible sources of error, and the complete-

ness of the discussion of the observational material, Keeler's memoir on this subject in Volume III of the *Publications of the Lick Observatory* takes rank with the best examples of astrophysical literature.

The spectroscopic demonstration of the meteoric constitution of Saturn's rings is perhaps the most striking of the many effective applications which have been made of Doppler's fruitful principle. It has already been pointed out that the displacement of a line is proportional to the velocity of the luminous source. If an image of Saturn is formed on the slit of a spectroscope placed parallel to the planet's equator it is evident that all the lines in the photograph of the spectrum will be slightly twisted out of the vertical position they would occupy if the planet were not rotating on its axis. The displacement due to the rotation increases uniformly from the center of the disk to the circumference, and the lines, though inclined, remain perfectly straight. If the rings were solid, forming a continuous mass with the ball of the planet, it is evident that the spectral lines would be direct extensions of those due to the disk. But Keeler found from a study of his photographs that in passing from the spectrum of the disk to that of the rings the lines were not only displaced as a whole, but twisted in the opposite direction. In other words, it appeared that the velocity of rotation of the inner edge of the ring is greater than that of the outer edge, a result evidently incompatible with the existence of a solid ring, but perfectly in harmony with what must be true if the rings consist of swarms of discrete particles. Careful measurements of the photographs furnished the first direct confirmation of the early theoretical researches of Maxwell, who had shown mathematically that the rings could not exist as solid bodies.

Much more might be said of Keeler's work, but this should suffice to indicate its

lasting value. It is a satisfaction to add that its merit has been widely appreciated, as has recently been evidenced by the award of the Draper and Rumford medals. Keeler was president of the Astronomical Society of the Pacific and a councilor of the Astronomical and Astrophysical Society of America. He was elected an Associate of the Royal Astronomical Society in 1898 and a member of the National Academy of Sciences at its last meeting. His kindly and genial manner, combined with unusual tact and rare judgment, drew to him many friends, who will long mourn his loss.

GEORGE E. HALE.

*ADDRESS OF THE PRESIDENT BEFORE THE
BRITISH ASSOCIATION FOR THE AD-
VANCEMENT OF SCIENCE.**

I.

TWENTY-SEVEN years ago the British Association met in Bradford, not at that time raised to the dignity of a city. The meeting was very successful, and was attended by about 2000 persons—a forecast, let us hope, of what we may expect at the present assembly. A distinguished chemist, Professor A. W. Williamson, presided. On this occasion the Association has selected for the presidential chair one whose attention has been given to the study of an important department of biological science. His claim to occupy, however unworthily, the distinguished position in which he has been placed, rests, doubtless, on the fact that, in the midst of the engrossing duties devolving on a teacher in a great university and school of medicine, he has endeavored to contribute to the sum of knowledge of the science which he professes. It is a matter of satisfaction to feel that the success of a meeting of this kind does not rest upon the shoulders of the occupant of the presidential chair, but is due to the eminence and active co-operation of the men of

* Given at Bradford on September 5, 1900.

science who either preside over or engage in the work of the nine or ten sections into which the Association is divided, and to the energy and ability for organization displayed by the local secretaries and committees. The program prepared by the general and local officers of the Association shows that no efforts have been spared to provide an ample bill of fare, both in its scientific and social aspects. Members and Associates will, I feel sure, take away from the Bradford meeting as pleasant memories as did our colleagues of the corresponding Association Française, when, in friendly collaboration at Dover last year, they testified to the common citizenship of the Universal Republic of Science. As befits a leading center of industry in the great county of York, the applications of science to the industrial arts and to agriculture will form subjects of discussion in the papers to be read at the meeting.

Since the Association was at Dover a year ago, two of its former presidents have joined the majority. The Duke of Argyll presided at the meeting in Glasgow so far back as 1855. Throughout his long and energetic life he proved himself to be an eloquent and earnest speaker, one who gave to the consideration of public affairs a mind of singular independence, and a thinker and writer in a wide range of human knowledge. Sir J. William Dawson was president at the meeting in Birmingham in 1886. Born in Nova Scotia in 1820, he devoted himself to the study of the geology of Canada, and became the leading authority on the subject. He took also an active and influential part in promoting the spread of scientific education in the Dominion, and for a number of years he was principal and vice-chancellor of the McGill University, Montreal.

SCIENTIFIC METHOD.

Edward Gibbon has told us that diligence and accuracy are the only merits

which an historical writer can ascribe to himself. Without doubt they are fundamental qualities necessary for historical research, but in order to bear fruit they require to be exercised by one whose mental qualities are such as to enable him to analyze the data brought together by his diligence, to discriminate between the false and the true, to possess an insight into the complex motives that determine human action, to be able to recognize those facts and incidents which had exercised either a primary or only a secondary influence on the affairs of nations, or on the thoughts and doings of the person whose character he is depicting.

In scientific research, also, diligence and accuracy are fundamental qualities. By their application new facts are discovered and tabulated, their order of succession is ascertained, and a wider and more intimate knowledge of the processes of nature is acquired. But to decide on their true significance a well-balanced mind and the exercise of prolonged thought and reflection are needed. William Harvey, the father of exact research in physiology, in his memorable work '*De Motu Cordis et Sanguinis*,' published more than two centuries ago, tell us of the great and daily diligence which he exercised in the course of his investigations, and the numerous observations and experiments which he collated. At the same time he refers repeatedly to his cogitations and reflections on the meaning of what he had observed, without which the complicated movements of the heart could not have been analyzed, their significance determined, and the circulation of the blood in a continuous stream definitely established. Early in the present century, Carl Ernst von Baer, the father of embryological research, showed the importance which he attached to the combination of observation with meditation by placing side by side on the title page of his famous treatise '*Ueber*

Entwicklungsgeschichte der Thiere' (1828) the words *Beobachtung und Reflexion*.

Though I have drawn from biological science my illustrations of the need of this combination, it must not be inferred that it applies exclusively to one branch of scientific inquiry; the conjunction influences and determines progress in all the sciences, and when associated with a sufficient touch of imagination, when the power of seeing is conjoined with the faculty of foreseeing, of projecting the mind into the future, we may expect something more than the discovery of isolated facts; their co-ordination and the enunciation of new principles and laws will necessarily follow.

Scientific method consists, therefore, in close observation, frequently repeated so as to eliminate the possibility of erroneous seeing; in experiments checked and controlled in every direction in which fallacies might arise; in continuous reflection on the appearances and phenomena observed, and in logically reasoning out their meaning and the conclusions to be drawn from them. Were the method followed out in its integrity by all who are engaged in scientific investigations, the time and labor expended in correcting errors committed by ourselves or by other observers and experimentalists would be saved, and the volumes devoted annually to scientific literature would be materially diminished in size. Were it applied, as far as the conditions of life admit, to the conduct and management of human affairs, we should not require to be told, when critical periods in our welfare as a nation arise, that we shall muddle through somehow. Recent experience has taught us that wise discretion and careful prevision are as necessary in the direction of public affairs as in the pursuit of science, and in both instances, when properly exercised, they enable us to reach with comparative certainty the goal which we strive to attain.

IMPROVEMENTS IN MEANS OF OBSERVATION.

Whilst certain principles of research are common to all the sciences, each great division requires for its investigation specialized arrangements to insure its progress. Nothing contributes so much to the advancement of knowledge as improvements in the means of observation, either by the discovery of new adjuncts to research, or by a fresh adaptation of old methods. In the industrial arts, the introduction of a new kind of raw material, the recognition that a mixture or blending is often more serviceable than when the substances employed are uncombined, the discovery of new processes of treating the articles used in manufactures, the invention of improved machinery, all lead to the expansion of trade, to the occupation of the people, and to the development of great industrial centers. In science, also, the invention and employment of new and more precise instruments and appliances enable us to appreciate more clearly the signification of facts and phenomena which were previously obscure, and to penetrate more deeply into the mysteries of nature. They mark fresh departures in the history of science, and provide a firm base of support from which a continuous advance may be made and fresh conceptions of nature can be evolved.

It is not my intention, even had I possessed the requisite knowledge, to undertake so arduous a task as to review the progress which has recently been made in the great body of sciences which lie within the domain of the British Association. As my occupation in life has required me to give attention to the science which deals with the structure and organization of the bodies of man and animals—a science which either includes within its scope or has intimate and widespread relations to comparative anatomy, embryology, morphology, zoology, physiology, and anthropology—I shall limit myself to the attempt to bring before you

some of the more important observations and conclusions which have a bearing on the present position of the subject. As this is the closing year of the century it will not, I think, be out of place to refer to the changes which a hundred years have brought about in our fundamental conceptions of the structure of animals. In science, as in business, it is well from time to time to take stock of what we have been doing, so that we may realize where we stand and ascertain the balance to our credit in the scientific ledger.

So far back as the time of the ancient Greeks it was known that the human body and those of the more highly organized animals were not homogeneous, but were built up of parts, the *partes dissimilares* (τὰ ἀνόμοια μέρη) of Aristotle, which differed from each other in form, color, texture, consistency and properties. These parts were familiarly known as the bones, muscles, sinews, blood-vessels, glands, brain, nerves, and so on. As the centuries rolled on, and as observers and observations multiplied, a more and more precise knowledge of these parts throughout the animal kingdom was obtained, and various attempts were made to classify animals in accordance with their forms and structure. During the concluding years of the last century and the earlier part of the present, the Hunters, William and John, in our country, the Meckels in Germany, Cuvier and St. Hilaire in France, gave an enormous impetus to anatomical studies, and contributed largely to our knowledge of the construction of the bodies of animals. But whilst by these and other observers the most salient and, if I may use the expression, the grosser characters of animal organization had been recognized, little was known of the more intimate structure or texture of the parts. So far as could be determined by the unassisted vision, and so much as could be recognized by the use of

a simple lens, had indeed been ascertained, and it was known that muscles, nerves and tendons were composed of threads or fibers, that the blood- and lymph-vessels were tubes, and that the parts which we call fasciæ and aponeuroses were thin membranes, and so on.

Early in the present century Xavier Bichat, one of the most brilliant men of science during the Napoleonic era in France, published his '*Anatomie Générale*,' in which he formulated important general principles. Every animal is an assemblage of different organs, each of which discharges a function, and acting together, each in its own way, assists in the preservation of the whole. The organs are, as it were, special machines situated in the general building which constitutes the factory or body of the individual. But, further, each organ or special machine is itself formed of tissues which possess different properties. Some, as the blood-vessels, nerves, fibrous tissues, etc., are generally distributed throughout the animal body, whilst others, as bones, muscles, cartilage, etc., are found only in certain definite localities. Whilst Bichat had acquired a definite philosophical conception of the general principles of construction and of the distribution of the tissues, neither he nor his pupil Béclard was in a position to determine the essential nature of the structural elements. The means and appliances at their disposal and at that of other observers in their generation were not sufficiently potent to complete the analysis.

Attempts were made in the third decennium of this century to improve the methods of examining minute objects by the manufacture of compound lenses, and, by doing away with chromatic and spherical aberration, to obtain, in addition to magnification of the object, a relatively large flat field of vision with clearness and sharpness of definition. When in January, 1830,

Joseph Jackson Lister read to the Royal Society his memoir '*On some properties in achromatic object-glasses applicable to the improvement of microscopes*,' he announced the principles on which combinations of lenses could be arranged, which would possess these qualities. By the skill of our opticians, microscopes have now for more than half a century been constructed which, in the hands of competent observers, have influenced and extended biological science with results comparable with those obtained by the astronomer through improvements in the telescope.

In the study of the minute structure of plants and animals the observer has frequently to deal with tissues and organs, most of which possess such softness and delicacy of substance and outline that, even when microscopes of the best construction are employed, the determination of the intimate nature of the tissue, and the precise relation which one element of an organ bears to the other constituent elements, is in many instances a matter of difficulty. Hence additional methods have had to be devised in order to facilitate study and to give precision and accuracy to our observations. It is difficult for one of the younger generation of biologists, with all the appliances of a well-equipped laboratory at his command, with experienced teachers to direct him in his work, and with excellent text-books, in which the modern methods are described, to realize the conditions under which his predecessors worked half a century ago. Laboratories for minute biological research had not been constructed, the practical teaching of histology and embryology had not been organized, experience in methods of work had not accumulated; each man was left to his individual efforts, and had to puzzle his way through the complications of structure to the best of his power. Staining and hardening reagents were unknown. The double-

bladed knife invented by Valentin, held in the hand, was the only improvement on the scapel or razor for cutting thin, more or less translucent slices suitable for microscopic examination; mechanical section cutters and freezing arrangements had not been devised. The tools at the disposal of the microscopist were little more than knife, forceps, scissors, needles; with acetic acid, glycerine and Canada balsam as reagents. But in the employment of the newer methods of research care has to be taken, more especially when hardening and staining reagents are used, to discriminate between appearances which are to be interpreted as indicating natural characters, and those which are only artificial productions.

Notwithstanding the difficulties attendant on the study of the more delicate tissues, the compound achromatic microscope provided anatomists with an instrument of great penetrative power. Between the years 1830 and 1850 a number of acute observers applied themselves with much energy and enthusiasm to the examination of the minute structure of the tissues and organs in plants and animals.

CELL THEORY.

It had, indeed, long been recognized that the tissues of plants were to a large extent composed of minute vesicular bodies, technically called cells (Hooke, Malpighi, Grew). In 1831 the discovery was made by the great botanist, Robert Brown, that in many families of plants a circular spot, which he named areola or nucleus, was present in each cell; and in 1838 M. J. Schleiden published the fact that a similar spot or nucleus was a universal elementary organ in vegetables. In the tissues of animals also structures had begun to be recognized comparable with the cells and nuclei of the vegetable tissues, and in 1839 Theodore Schwann announced the important generalization that there is one universal princi-

ple of development for the elementary part of organisms, however different they may be in appearance, and that this principle is the formation of cells. The enunciation of the fundamental principle that the elementary tissues consisted of cells constituted a step in the progress of biological science, which will forever stamp the century now drawing to a close with a character and renown equalling those which it has derived from the most brilliant discoveries in the physical sciences. It provided biologists with the visible anatomical units through which the external forces operating on, and the energy generated in, living matter come into play. It dispelled forever the old mystical idea of the influence exercised by vapors or spirits in living organisms. It supplied the physiologist and pathologist with the specific structures through the agency of which the functions of organisms are discharged in health and disease. It exerted an enormous influence on the progress of practical medicine. A review of the progress of knowledge of the cell may appropriately enter into an address on this occasion.

STRUCTURE OF CELLS.

A cell is a living particle, so minute that it needs a microscope for its examination; it grows in size, maintains itself in a state of activity, responds to the action of stimuli, reproduces its kind, and in the course of time it degenerates and dies.

Let us glance at the structure of a cell to determine its constituent parts and the rôle which each plays in the function to be discharged. The original conception of a cell, based upon the study of the vegetable tissues, was a minute vesicle enclosed by a definite wall, which exercised chemical or metabolic changes on the surrounding material and secreted into the vesicle its characteristic contents. A similar conception was at first also entertained regarding the cells of animal tissues; but as observations

multiplied, it was seen that numerous elementary particles, which were obviously in their nature cells, did not possess an enclosing envelope. A wall ceased to have a primary value as a constituent part of a cell, the necessary vesicular character of which therefore could no longer be entertained.

The other constituent parts of a cell are the cell plasm, which forms the body of the cell, and the nucleus imbedded in its substance. Notwithstanding the very minute size of the nucleus, which even in the largest cells is not more than $\frac{1}{500}$ th inch in diameter, and usually is considerably smaller, its almost constant form, its well-defined sharp outline, and its power of resisting the action of strong reagents when applied to the cell, have from the period of its discovery by Robert Brown caused histologists to bestow on it much attention. Its structure and chemical composition; its mode of origin; the part which it plays in the formation of new cells, and its function in nutrition and secretion have been investigated.

When examined under favorable conditions in its passive or resting state, the nucleus is seen to be bounded by a membrane which separates it from the cell plasm and gives it the characteristic sharp contour. It contains an apparently structureless nuclear substance, nucleoplasm or enchylema, in which are embedded one or more extremely minute particles called nucleoli, along with a network of exceedingly fine threads or fibers, which in the active living cell play an essential part in the production of new nuclei within the cell. In its chemical composition the nuclear substance consists of albuminous plasmin and globulin; and of a special material named nuclein, rich in phosphorus and with an acid reaction. The delicate network within the nucleus consists apparently of the nuclein, a substance which stains with

carmine and other dyes, a property which enables the changes, which take place in the network in the production of young cells, to be more readily seen and followed out by the observer.

The mode of origin of the nucleus and the part which it plays in the production of new cells have been the subject of much discussion. Schleiden, whose observations, published in 1838, were made on the cells of plants, believed that within the cell a nucleolus first appeared, and that around it molecules aggregated to form the nucleus. Schwann again, whose observations were mostly made on the cells of animals, considered that an amorphous material existed in organized bodies, which he called cytoblastema. It formed the contents of cells, or it might be situated free or external to them. He figuratively compared it to a mother liquor in which crystals are formed. Either in the cytoblastema within the cells or in that situated external to them, the aggregation of molecules around a nucleolus to form a nucleus might occur, and, when once the nucleus had been formed, in its turn it would serve as a center of aggregation of additional molecules from which a new cell would be produced. He regarded therefore the formation of nuclei and cells as possible in two ways: one within pre-existing cells (endogenous cell-formation), the other in a free blastema lying external to cells (free cell-formation). In animals, he says, the endogenous method is rare, and the customary origin is in an external blastema. Both Schleiden and Schwann considered that after the cell was formed the nucleus had no permanent influence on the life of the cell, and usually disappeared.

Under the teaching principally of Henle, the famous Professor of Anatomy in Göttingen, the conception of the free formation of nuclei and cells in a more or less fluid blastema, by an aggregation of elementary granules and molecules, obtained so much

credence, especially amongst those who were engaged in the study of pathological processes, that the origin of cells within pre-existing cells was to a large extent lost sight of. That a parent cell was requisite for the production of new cells seemed to many investigators to be no longer needed. Without doubt this conception of free cell-formation contributed in no small degree to the belief, entertained by various observers that the simplest plants and animals might arise, without pre-existing parents, in organic fluids destitute of life, by a process of spontaneous generation; a belief which prevailed in many minds almost to the present day. If, as has been stated, the doctrine of abiogenesis cannot be experimentally refuted, on the other hand it has not been experimentally proved. The burden of proof lies with those who hold the doctrine, and the evidence that we possess is all the other way.

MULTIPLICATION OF CELLS.

Although von Mohl, the botanist, seems to have been the first to recognize (1835) in plants a multiplication of cells by division, it was not until attention was given to the study of the egg in various animals, and to the changes which take place in it, attendant on fertilization, that in the course of time a much more correct conception of the origin of the nucleus and of the part which it plays in the formation of new cells was obtained. Before Schwann had published his classical memoir in 1839, von Baer and other observers had recognized within the animal ovum the germinal vesicle, which obviously bore to the ovum the relation of a nucleus to a cell. As the methods of observation improved, it was recognized that, within the developing egg, two vesicles appeared where one only had previously existed, to be followed by four vesicles, then eight, and so on in multiple progression until the ovum contained a

multitude of vesicles, each of which possessed a nucleus. The vesicles were obviously cells which had arisen within the original germ-cell or ovum. These changes were systematically described by Martin Barry so long ago as 1839 and 1840 in two memoirs communicated to the Royal Society of London, and the appearance produced, on account of the irregularities of the surface occasioned by the production of new vesicles, was named by him the mulberry-like structure. He further pointed out that the vesicles arranged themselves as a layer within the envelope of the egg or zona pellucida, and that the whole embryo was composed of cells filled with the foundations of other cells. He recognized that the new cells were derived from the germinal vesicle or nucleus of the ovum, the contents of which entered into the formation of the first two cells, each of which had its nucleus, which in its turn resolved itself into other cells, and by a repetition of the process into a greater number. The endogenous origin of new cells within a pre-existing cell and the process which we now term the segmentation of the yolk were successfully demonstrated. In a third memoir, published in 1841, Barry definitely stated that young cells originated through division of the nucleus of the parent cell, instead of arising, as a product of crystallization, in the fluid cytotlastema of the parent cell or in a blastema situated external to the cell.

In a memoir published in 1842, John Goodsir advocated the view that the nucleus is the reproductive organ of the cell, and that from it, as from a germinal spot, new cells were formed. In a paper, published three years later, on nutritive centers, he described cells, the nuclei of which were the permanent source of successive broods of young cells, which from time to time occupied the cavity of the parent cell. He extended also his observations on the

endogenous formation of cells to the cartilage cells in the process of inflammation and to other tissues undergoing pathological changes. Corroborative observations on endogenous formation were also given by his brother Harry Goodsir in 1845. These observations on the part which the nucleus plays by cleavage in the formation of young cells by endogenous development from a parent center—that an organic continuity existed between a mother cell and its descendants through the nucleus—constituted a great step in advance of the views entertained by Schleiden and Schwann, and showed that Barry and the Goodsirs had a deeper insight into the nature and functions of cells than was possessed by most of their contemporaries, and are of the highest importance when viewed in the light of recent observations.

In 1841 Robert Remak published an account of the presence of two nuclei in the blood corpuscles of the chick and the pig, which he regarded as evidence of the production of new corpuscles by division of the nucleus within a parent cell; but it was not until some years afterwards (1850 to 1855) that he recorded additional observations and recognized that division of the nucleus was the starting-point for the multiplication of cells in the ovum and in the tissues generally. Remak's view was that the process of cell division began with the cleavage of the nucleolus, followed by that of the nucleus, and that again by cleavage of the body of the cell and of its membrane. Kölliker had previously, in 1843, described the multiplication of nuclei in the ova of parasitic worms, and drew the inference that in the formation of young cells within the egg the nucleus underwent cleavage, and that each of its divisions entered into the formation of a new cell. By these observations, and by others subsequently made, it became obvious that the multiplication of animal cells, either by division of the

nucleus within the cell, or by the budding off of a part of the protoplasm of the cell, was to be regarded as a widely spread and probably a universal process, and that each new cell arose from a parent cell.

Pathological observers were, however, for the most part inclined to consider free cell-formation in a blastema or exudation by an aggregation of molecules, in accordance with the views of Henle, as a common phenomenon. This proposition was attacked with great energy by Virchow in a series of memoirs published in his 'Archiv,' commencing in Vol. I., 1847, and finally received its death-blow in his published lectures on 'Cellular Pathology,' 1858. He maintained that in pathological structures there was no instance of cell development *de novo*; where a cell existed, there one must have been before. Cell-formation was a continuous development by descent, which he formulated in the expression *omnis cellula e cellula*.

KARYOKINESIS.

Whilst the descent of cells from pre-existing cells by division of the nucleus during the development of the egg, in the embryos of plants and animals, and in adult vegetable and animal tissues, both in healthy and diseased conditions, had now become generally recognized, the mechanism of the process by which the cleavage of the nucleus took place was for a long time unknown. The discovery had to be deferred until the optician had been able to construct lenses of a higher penetrative power, and the microscopist had learned the use of coloring agents capable of dyeing the finest elements of the tissues. There was reason to believe that in some cases a direct cleavage of the nucleus, to be followed by a corresponding division of the cell into two parts, did occur. In the period between 1870 and 1880 observations were made by Schneider, Strasburger, Bütschli,

Fol, van Beneden and Flemming, which showed that the division of the nucleus and the cell was due to a series of very remarkable changes, now known as indirect nuclear and cell division, or karyokinesis. The changes within the nucleus are of so complex a character that it is impossible to follow them in detail without the use of appropriate illustrations. I shall have to content myself, therefore, with an elementary sketch of the process.

I have previously stated that the nucleus in its passive or resting stage contains a very delicate network of threads or fibers. The first stage in the process of nuclear division consists in the threads arranging themselves in loops and forming a compact coil within the nucleus. The coil then becomes looser, the loops of threads shorten and thicken, and somewhat later each looped thread splits longitudinally into two portions. As the threads stain when coloring agents are applied to them, they are called chromatin fibers, and the loose coil is the chromosome (Waldeyer).

As the process continues, the investing membrane of the nucleus disappears, and the loops of threads arrange themselves within the nucleus so that the closed ends of the loops are directed to a common center, from which the loops radiate outwards and produce a starlike figure (aster). At the same time clusters of extremely delicate lines appear both in the nucleoplasm and in the body of the cell, named the achromatic figure, which has a spindle-like form with two opposite poles, and stains much more feebly than the chromatic fibers. The loops of the chromatic star then arrange themselves in the equatorial plane of the spindle, and bending round turn their closed ends towards the periphery of the nucleus and the cell.

The next stage marks an important step in the process of division of the nucleus. The two longitudinal portions, into which

each looped thread had previously split, now separate from each other, and whilst one part migrates to one pole of the spindle, the other moves to the opposite pole, and the free ends of each loop are directed towards its equator (metakinesis). By this division of the chromatin fibers, and their separation from each other to opposite poles of the spindle, two star-like chromatin figures are produced (dyaster).

Each group of fibers thickens, shortens, becomes surrounded by a membrane, and forms a new or daughter nucleus (dispirem). Two nuclei therefore have arisen within the cell by the division of that which had previously existed, and the expression formulated by Flemming—*omnis nucleus e nucleo*—is justified. Whilst this stage is in course of being completed, the body of the cell becomes constricted in the equatorial plane of the spindle, and, as the constriction deepens, it separates into two parts, each containing a daughter nucleus, so that two nucleated cells have arisen out of a pre-existing cell.

A repetition of the process in each of these cells leads to the formation of other cells, and, although modifications in details are found in different species of plants and animals, the multiplication of cells in the egg and in the tissues generally on similar lines is now a thoroughly established fact in biological science.

In the study of karyokinesis, importance has been attached to the number of chromosomes in the nucleus of the cell. Flemming had seen in the Salamander twenty-four chromosome fibers, which seems to be a constant number in the cells of epithelium and connective tissues. In other cells again, especially in the ova of certain animals, the number is smaller, and fourteen, twelve, four, and even two only have been described. The theory formulated by Boveri that the number of chromosomes is constant for each species, and that in the

karyokinetic figures corresponding numbers are found in homologous cells, seems to be not improbable.

In the preceding description I have incidentally referred to the appearance in the proliferating cell of an achromatic spindle-like figure. Although this was recognized by Fol in 1873, it is only during the last ten or twelve years that attention has been paid to its more minute arrangements and possible signification in cell-division.

The pole at each end of the spindle lies in the cell plasm which surrounds the nucleus. In the center of each pole is a somewhat opaque spot (central body) surrounded by a clear space, which, along with the spot, constitutes the centrosome or the sphere of attraction. From each centrosome extremely delicate lines may be seen to radiate in two directions. One set extends towards the pole at the opposite end of the spindle, and, meeting or coming into close proximity with radiations from it, constitutes the body of the spindle, which, like a perforated mantle, forms an imperfect envelope around the nucleus during the process of division. The other set of radiations is called the polar, and extends in the region of the pole towards the periphery of the cell.

The question has been much discussed whether any constituent part of the achromatic figure, or the entire figure, exists in the cell as a permanent structure in its resting phase; or if it is only present during the process of karyokinesis. During the development of the egg the formation of young cells, by division of the segmentation nucleus, is so rapid and continuous that the achromatic figure, with the centrosome in the pole of the spindle, is a readily recognizable object in each cell. The polar and spindle-like radiations are in evidence during karyokinesis, and have apparently a temporary endurance and function. On the other hand, van Beneden and Boveri

were of opinion that the central body of the centrosome did not disappear when the division of the nucleus came to an end, but that it remained as a constituent part of a cell lying in the cell plasm near to the nucleus. Flemming has seen the central body with its sphere in leucocytes, as well as in epithelial cells and those of other tissues. Subsequently Heidenhain and other histologists have recorded similar observations. It would seem, therefore, as if there were reason to regard the centrosome, like the nucleus, as a permanent constituent of a cell. This view, however, is not universally entertained. If not always capable of demonstration in the resting stage of a cell, it is doubtless to be regarded as potentially present, and ready to assume, along with the radiations, a characteristic appearance when the process of nuclear division is about to begin.

One can scarcely regard the presence of so remarkable an appearance as the achromatic figure without associating with it an important function in the economy of the cell. As from the centrosome at the pole of the spindle both sets of radiations diverge, it is not unlikely that it acts as a center or sphere of energy and attraction. By some observers the radiations are regarded as substantive fibrillar structures, elastic or even contractile in their properties. Others, again, look upon them as morphological expressions of chemical and dynamical energy in the protoplasm of the cell body. On either theory we may assume that they indicate an influence, emanating, it may be, from the centrosome, and capable of being exercised both on the cell plasm and on the nucleus contained in it. On the contractile theory, the radiations which form the body of the spindle, either by actual traction of the supposed fibrillæ or by their pressure on the nucleus which they surround, might impel during karyokinesis the dividing chromosome elements towards the poles of

the spindle, to form there the daughter nuclei. On the dynamical theory, the chemical and physical energy in the centrosome might influence the cell plasm and the nucleus, and attract the chromosome elements of the nucleus to the poles of the spindle. The radiated appearance would therefore be consequent and attendant on the physico-chemical activity of the centrosome. One or other of these theories may also be applied to the interpretation of the significance of the polar radiations.

CELL PLASM.

In the cells of plants, in addition to the cell wall, the cell body and the cell juice require to be examined. The material of the cell body, or the cell contents, was named by von Mohl (1846) protoplasm, and consisted of a colorless tenacious substance which partly lined the cell wall (primordial utricle), and partly traversed the interior of the cell as delicate threads enclosing spaces (vacuoles) in which the cell juice was contained. In the protoplasm the nucleus was embedded. Nägeli, about the same time, had also recognized the difference between the protoplasm and the other contents of vegetable cells, and had noticed its nitrogenous composition.

Though the analogy with a closed bladder or vesicle could no longer be sustained in the animal tissues, the name 'cell' continued to be retained for descriptive purposes, and the body of the cell was spoken of as a more or less soft substance enclosing a nucleus (Leydig). In 1861 Max Schultze adopted for the substance forming the body of the animal cell the term 'protoplasm.' He defined a cell to be a particle of protoplasm in the substance of which a nucleus was situated. He regarded the protoplasm, as indeed had previously been pointed out by the botanist Unger, as essentially the same as the contractile sarcode which constitutes the body and pseudopodia of the

Amœba and other Rhizopoda. As the term 'protoplasm,' as well as that of 'bioplasm,' employed by Lionel Beale in a somewhat similar though not precisely identical sense, involves certain theoretical views of the origin and function of the body of the cell, it would be better to apply to it the more purely descriptive term 'cytoplasm' or 'cell plasm.'

Schultze defined protoplasm as a homogeneous, glassy, tenacious material, of a jelly-like or somewhat firmer consistency, in which numerous minute granules were embedded. He regarded it as the part of the cell especially endowed with vital energy, whilst the exact function of the nucleus could not be defined. Based upon this conception of the jelly-like character of protoplasm, the idea for a time prevailed that a structureless, dimly granular jelly or slime destitute of organization, possessed great physiological activity, and was the medium through which the phenomena of life were displayed.

More accurate conceptions of the nature of the cell plasm soon began to be entertained. Brücke recognized that the body of the cell was not simple, but had a complex organization. Flemming observed that the cell plasm contained extremely delicate threads, which frequently formed a network, the interspaces of which were occupied by a more homogeneous substance. Where the threads crossed each other, granular particles (mikrosomen) were situated. Bütschli considered that he could recognize in the cell plasm a honeycomb-like appearance, as if it consisted of excessively minute chambers in which a homogeneous more or less fluid material was contained. The polar and spindle-like radiations visible during the process of karyokinesis, which have already been referred to, and the presence of the centrosome, possibly even during the resting stage of the cell, furnished additional illustra-

tions of differentiation within the cell plasm. In many cells there appears also to be a difference in the character of the cell plasm which immediately surrounds the nucleus and that which lies at and near the periphery of the cell. The peripheral part (ektoplasma) is more compact and gives a definite outline to the cell, although not necessarily differentiating into a cell membrane. The inner part (endoplasma) is softer, and is distinguished by a more distinct granular appearance, and by containing the products specially formed in each particular kind of cell during the nutritive process.

By the researches of numerous investigators on the internal organization of cells in plants and animal, a large body of evidence has now been accumulated, which shows that both the nucleus and the cell plasm consist of something more than a homogeneous, more or less viscid, slimy material. Recognizable objects in the form of granules, threads, or fibers can be distinguished in each. The cell plasm and the nucleus respectively are therefore not of the same constitution throughout, but possess polymorphic characters, the study of which in health and the changes produced by disease will for many years to come form important matters for investigation.

WILLIAM TURNER.

(*To be concluded.*)

EXPERIMENTS OF J. J. THOMSON ON THE STRUCTURE OF THE ATOM.

RECENT ideas as to the stability of the chemical molecule have been much modified by the evidence that it is readily dissociated when a substance is dissolved in water.

The researches now being carried on by J. J. Thomson and his assistants on the electrical conduction of gases seem to require an even more radical and sweeping

change in our conception of the structure of the atom itself.

Ordinary gases are perfect non-conductors of electricity of low electromotive force. Electricity may, however, pass through them, more or less readily, under certain conditions, viz :

1. When the electromotive force is sufficient to produce a spark.
2. When the pressure of the gas is much reduced and a sufficient electromotive force is applied; as in a 'vacuum tube.'
3. When the gas is heated very hot, or has been recently in violent chemical activity, as in the region above a flame.
4. When the negative electrode is illuminated by ultra-violet light.
5. When the gas has been very recently exposed to Röntgen rays or to the similar rays proceeding from uranium, radium, etc.

Thomson's investigations on the conduction by sparks through gases at ordinary pressures, indicated that electrolysis took place somewhat as in solutions, and that the amount of decomposition was, in several cases, essentially the same as in the decomposition of solutions. In the case of hot gases and the gases in a vacuum tube, also there was evidence that the conduction was by means of 'ions' or portions of broken-down molecules which acted as carriers for the current.

When an electric current passes through a solution, it is a fundamental law that a univalent atom of any substance carries precisely the same charge as a univalent atom of any other substance, while a bivalent atom carries just twice this charge. The exact charge carried by one atom cannot be known until we know the exact weight of the atom; but the charge carried by 1 gramme of atoms (e/m) is about 10,000 units in the case of hydrogen. For any other univalent substance, the weight required to carry this charge is greater in

proportion as its atoms are heavier than those of hydrogen.

Thomson has undertaken to find the charge carried by the gaseous ion as follows: When the discharge of an induction coil is sent through a vacuum tube, there is seen a luminous glow, stretching in a straight line from the electrode to the wall of the tube. This glow, called the 'cathode ray' would seem to be a stream of negatively charged particles, from the cathode, or negative terminal in the tube, projected in a straight line until some solid obstacle is encountered. This cathode ray, when it meets the tube, or any body in its path, may produce fluorescence; it always produces heating, it also excites the vibrations called by Röntgen the X-ray.

A magnet held near the cathode ray draws it to one side, as if it were a conductor carrying an electric current. Professor Thomson has made use of this property to determine the ratio e/m for the electrified particles. Of course the more strongly the flying particles are charged, the more they will be drawn aside from their rectilinear path, while the heavier the particles, the more nearly would their inertia keep them in a straight line. The ratio of the charge to the mass of a particle determines its velocity at right angles to the original direction.

Again, the flying stream may be drawn aside from its course by an electrified plate at the side of the stream, by which it will be attracted or repelled according as the plate has a positive or negative charge.

Both these methods for deflecting the ray were employed. The energy of the flying particles was also determined from the heat which they produced when directed upon a thermopile; and the ratio of the charge upon the particles to their mass was thus found to be about 10^7 , or nearly 1000 times as large as for the hydrogen atom in the electrolysis of solutions.

Again, when ultra-violet light falls upon an amalgamated zinc plate, the gas near the plate becomes conducting. Here again if a magnetic field is produced near the plate, the path of the charged particles is changed. This path can no longer be seen, as in the cathode ray; it may, however, be inferred from the change of conduction, when the distance between the electrodes is varied. The ratio of the charge to the mass of the particles is, in this case, the same as in the cathode ray, as above determined.

If, as is believed, the electric current in these cases consists of a stream of charged particles, we are apparently shut up to the alternative that the charge of each ion is 1000 times as great as is found in solutions, or that the mass of the ions is $\frac{1}{1000}$ as great as that of the hydrogen atom. Probably the former supposition seems much less opposed to our preconceived ideas than the latter, but it is a question to be decided by experiment rather than by preconceived ideas.

To make a direct measurement of the mass of the single ions, or particles taking part in electric conduction, Thomson examined air which had been rendered conducting by exposure to Röntgen rays. The quantity of electricity carried by such air is measured without special difficulty. To count the number of ions taking part in the conduction is quite another matter. This counting has, however, been actually accomplished in the following manner: Damp air, which has been freed from dust by filtering, is exposed to the Röntgen rays and its conductivity determined; it is then suddenly expanded to $1\frac{1}{3}$ times its volume. The expansion and consequent cooling, causes a fine fog or mist to form. It has been found that when such a mist is formed, there is at the center of each drop, a minute particle of dust, or other substance, upon which condensation has taken place. In this case, all the dust had been filtered out,

but the charged ions performed the same duty of allowing condensation to begin, and hence the number of water drops is the same as the number of ions present in the air. To count the number of drops, the weight of the cloud is determined by a sensitive balance. They are also allowed to settle in a bell jar, and the rate of settling is observed. The calculations of Stokes, based upon the viscosity of air, show at what rate drops of different size will fall, and from this, the size of the water drops is determined. The size of the drops and the weight of the cloud give the total number of drops in the cloud, and hence the number of ions present in the air.

The result of this experiment turns out to be that the number of ions, carrying a unit quantity of electricity is perhaps a little less, certainly not very different, from the number carrying a unit quantity in the case of solutions. The other alternative seems to be the true one, that the mass of each ion (or 'corpuscle' as Thomson calls them) has about $\frac{1}{1000}$ the mass of the hydrogen atom. More than this, it seems to be the same for all the gases tried, instead of differing with their atomic weight, indicating that all these gases give off corpuscles of the same mass.

These results, revolutionary as they are, fit in well with some other facts. Thus, the stream of electrified particles constituting the cathode ray, is found to penetrate a mass of air much farther than would be expected if the ray were composed of particles as large as atoms, but just about as far as if they were $\frac{1}{1000}$ as large as hydrogen atoms. They also penetrate all gases in the inverse ratio of their densities. However, if the reason for this is to be found in the fact that their molecules are all built up of corpuscles of the same kind, it must also be true that the structure of the molecules is extremely porous, allowing the corpuscles to pass through them with great freedom.

Further confirmation of this theory is

found in a recent discovery by Zeeman in spectrum analysis. When a luminous gas is between the poles of an electromagnet, the lines of its spectrum are found to be affected in such wise as to indicate that the particles whose vibrations produce the light are electrified; and the ratio of the charge to the mass of the particles is found to be the same as for Thomson's 'corpuscles.' Mendelèef, who has grouped the chemical elements into a remarkable series of families, says "the periodic law together with the revelations of spectrum analysis, have contributed again to revive an old, but remarkably long-lived hope, that of discovering * * * the primary matter, which had its genesis in the minds of the Grecian philosophers, and has been transmitted, together with many other ideas of the classic period, to the heirs of their civilization." "From the failures of so many attempts at finding in experiment and speculation, a proof of the compound character of the elements, and of the existence of primordial matter, it is evident, in my opinion, that this theory must be classed among mere Utopias."

It would seem that a beginning has been made in attaining this Utopia. The theory is too new and too extreme to have received the scrutiny and the criticism which it deserves. It yet remains to be seen whether it is consistent with the low internal energy of gaseous molecules, or whether it will prove valuable in explaining the electrical, magnetic or chemical properties of bodies. Its author has already published a number of suggestive 'speculations' as to the part played by corpuscles in electrical and heat conduction, in the Thomson effect, in the magnetism of rotating matter (terrestrial magnetism?) and in a number of the other electrical properties of bodies, which at least indicate some of the possibilities of the new theory in the domain of molecular physics.

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INVESTIGATIONS AT COLD SPRING HARBOR.

THE investigations at this Laboratory during the present summer have covered a wide field as the following enumeration of subjects and abstracts shows. In Botany work is being done in the determination of the species of the rich cryptogamic flora of the vicinity, in the study of the tension zone where fresh water and marine species meet and in various other ecological matters. In Zoology, investigations are being carried out on the supermatogenesis of certain higher crustacea, on the development of Trematodes, of Squilla, of Phascolosoma, of Pectinatella and of Hemiptera. Studies on the development of color markings in insects have made good progress, the insect fauna is being systematically studied, and the food habits of fishes are being analyzed. Quantitative variation studies are being carried out on sea anemones, Daphnia, Amphipoda, lamellibranchs, Myriapoda, several groups of insects and mice. The following brief statements give further details concerning some of these studies.

Cryptogamic Studies at Cold Spring Harbor:

By DR. D. S. JOHNSON.

The work accomplished in the study of the cryptogams, aside from class work, has been chiefly systematic, including a study of the distribution of the marine algae in various parts of Cold Spring Harbor, Huntington Harbor, and Smithtown Bay. Few new forms have been added to the flora, but forms hitherto known only from free fragments have been found abundantly in their natural habitat. Many notes have also been made as to the different species preponderating in the same locality in different years. Fungi have been much restricted in distribution and numbers because of the dry season, but several interesting finds have been made. Of the Myxomycetes, Mr. D. N. Shoemaker has added twelve additional genera and thirty-eight

additional species to those reported from other sources in Jelliffe's list of Long Island plants and only one species mentioned by Jelliffe has not been seen here. Several specimens of Dictyophora (Ravenellii?) apparently new to the Island have been found and a group of over twenty specimens of *Simblum rubescens*, of which four had double stipes and an elongated receptaculum.

Studies in Ecology: By DR. HENRY C. COWLES.

The work in this department has been chiefly along two lines. Considerable attention has been paid to variations in form, especially in leaves, with a view to the suggestion of a series of hypotheses, which may be made the basis of further observation and experiment on these matters. Perhaps the most fruitful field of study has been in relation to the development of the Long Island vegetation in connection with the physiography. The succession of plant societies along the xerophytic shores strikingly resembles that along the Great Lakes. The genetic relations of salt, brackish and fresh swamps have been looked into, and one student has taken up this problem as a special field for research. Another student is preparing to make a comparative chemical analysis of forms which grow in both maritime and inland conditions. Two other students are contemplating leaf variation studies. Our present plans also include a series of culture experiments on halophytes conducted in the interior under various soil conditions.

Trematode Studies: By DR. H. S. PRATT.

The adult form of Apoblema (Distoma) appendiculatum has been found in considerable numbers in the menhaden, attached to the wall of the stomach. Immature forms of this worm have been plentiful at Cold Spring Harbor during the past five years, although they have not been observed at any other part of the Atlantic coast of this

country. They occur in the body-cavity of copepods and also free-swimming in the plankton.

Three species of Trematodes have been observed on the gills of *Fundulus heteroclitus*. Two of them are minute monogenetic Trematodes belonging to the genera *Tetraonchus* and *Gyrodactylus* which have not before been observed in North America. The species of *Tetraonchus* is undoubtedly a new one. It is found attached to the gills, from one to three individuals usually occurring on each fish. The species of *Gyrodactylus* was rare, but four individuals being found during five weeks on the large number of fishes examined. The species is probably new although it may prove to be identical with *G. Groenlandicus* Levinsen.

In addition to these monogenetic Trematodes large numbers of an encysted distomid worm belonging to the genus *Echinostomum* were also found. The cysts are oval in shape, each containing a single worm. These were found in all stages of development, the largest showing the two suckers, the digestive and excretory tracts, and the characteristic oral spines. In quite small fishes the cysts were either absent or contained very young worms, and numerous minute ciliated organisms, which were probably the miracidia of *Echinostomum* were found swimming rapidly over the surface of the gills or lying closely applied to them.

Development of Squilla Empusa: By DR. C. P. SIGERFOOS.

This interesting form has been found in great numbers and is apparently much more abundant than usual. It lives at low tide mark in muddy sand to soft mud, in burrows one to four feet or more in length and open at both ends. Observations on the development are in progress. The eggs, very numerous and less than a millimeter

in diameter, are cemented into a large plate, which is rolled into a bunch and carried in a basket formed by the anterior thoracic appendages. The incubation seems to be slow, and the larvæ are about all hatched before August 1st. The new-hatched larva is two and a half millimeters long and of much more advanced organization than in the forms described by Claus. It moults in three days. The later stages have been taken in the tow-net and at this writing (August 11th), are seven millimeters long and in perhaps the sixth or seventh stage. The smallest adults found are over ten centimeters long indicating that this size is attained in one year.

Variations in Color pattern produced by Changes in Temperature and Moisture: By W. L. TOWER.

The relations which exist between the variations of the color pattern, moisture and temperature conditions have been tested experimentally during the last two years in *Leptinotarsa decemlineata* Say, the Colorado potato beetle. Extremely abnormal conditions were avoided and only such deviations from the normal were used as might be encountered in different parts of North America. In several series of experiments known deviations of temperature and moisture were used and the results derived by quantitative methods.

The series of experiments show that a deviation above the normal (+) of either temperature or moisture, or both, up to a certain critical maximum, will produce melanism; but a deviation of either factor beyond this maximum will produce albinism. A deviation below the normal (—) produces albinism if both factors are —; but a + temperature and a — humidity produce albinic specimens; and a — temperature and a + humidity produce melanism up to the critical point where the opposite color variations begin to predominate.

A Study of the Variations in the Number of Grooves upon the Shells of Pecten irradians (Lam.): By FRANK E. LUTZ.

The material for this study was gathered from East Beach, Northport Bay, L. I., during the scallop season of 1899-1900. The Beach is an extremely well-protected one in an almost land-locked harbor. The results given by a count of five hundred specimens of each valve were as follows:

Lower valve.—Average = 17.456 ± 0.022 ; Standard Deviation = 0.726 ± 0.015 ; Coefficient of Variability = $4.163\% \pm 0.888\%$.

Upper valve.—Average = 17.110 ± 0.027 ; Standard Deviation = 0.922 ± 0.019 ; Coefficient of Variability = $5.388\% \pm 0.115\%$.

The curves obtained in both cases were nearly normal—that of the lower valve approaching the closer. The shells show the least variability of any Pectens yet studied.

Statistical Studies on Sand Fleas: By MABEL E. SMALLWOOD.

Five hundred sand fleas (*Talorchestia*), apparently adult, were gathered from the Sand Spit at Cold Spring Harbor. They ranged in length from 15 mm. to 27.5 mm. The length of the antennæ ranged from 5.5 mm. to 24.4 mm., the average was 13.01 mm. ± 0.14 mm. and the standard deviation was 4.67. Attempts to fit a theoretical unimodal curve were unsuccessful. From inspection of the distribution of frequencies it seems probable that the observed curve is multimodal with two principal modes placed so near together that their distinctness is hidden, and that these two modes correspond to two moultings. The length of the tentacle is proportionately much longer in the larger individuals and it seems probable that the two recognized species—*T. megalopthalma* and *T. longicornis* are merely two different moults of the same species. Breeding experiments are now in progress to test this conclusion.

Pedigree Mouse Breeding: By C. B. DAVENPORT.

Quantitative data are being collected from a colony of fifty mice of different races concerning inheritance of color and other measurable characteristics. Especially noteworthy are the relative prepotency of different races, reversion, the skipping of a generation in inheritance, the *localization* of white patches and of the other parental color-markings on particular parts of the body of the offspring. The results are not yet ready for publication.

C. B. DAVENPORT.

COLD SPRING HARBOR, L. I.,
August, 1900.

SCIENTIFIC BOOKS.

Tarr and McMurry's Geographies. First Book—Home Geography and the Earth as a Whole. Pp. xiii + 279. Second Book—North America, with an especial full treatment of the United States and its dependencies. By RALPH S. TARR and FRANK M. MCMURRY. New York, Macmillan. 1900. Pp. xviii + 469.

The first volume is a disappointment. The authors call it 'a radical innovation,' but the claim does not seem well founded. Apparently they have meant to make the Home Geography and the maps the *features*.

Home Geography is a misnomer for the book. The idea that the child ought to begin with the study of forms about him is good, but not new, and the idea is not realized in this volume. A few sentences connect hills and valleys and soils with environment; the mountains are said to look like clouds on the horizon. The rest is descriptive and not Home Geography at all.

Suggestions for further home study are appended to the chapters, 8 or 10 pages in the 280, but they are subordinate and will be neglected by most teachers as such, especially as teachers are still untrained in outdoor work.

For instance, the first suggestion is, "Find a place where men are digging a ditch or cellar, to see how the dirt looks below the surface"—an admirable thing to do, but the inertia of the

ages is against its realization. The children will not do that part of the work unless it is talked of in class and the teacher cannot make anything of it unless she goes and does the work herself. She will not go without stronger urgings than these footnote-like suggestions. There is no evidence in this book that the authors have ever tried to teach children to look about them, and it does not appear that teachers trained in books only will be inspired by this one to begin outdoor studies for themselves.

Putting aside the pretence of basing the book on home study, the introduction on Physical Geography is good, though Frye is a predecessor in that line, and a worthy one.

The portion of the volume that treats of the United States is interesting and admirable, brightened continually by bits of realistic description from personal knowledge that are very effective. The pictures here, too, are admirable, for instance, the cowboy and horse at page 182.

The basing of descriptions on Physiography might be better. Thus in accounting for the greatness of New York City the hollow across the Appalachians in which the Mohawk flows is not mentioned and the real connection of New York with the interior not pointed out. For anything pointed out in the book the Mohawk might enter the Hudson by a narrow cañon. Yet canal and railroads are but utilizations of the open valley. Again, 'sinking of the land' cannot be bluntly stated to children as an intelligent reason for the embayed coast. The idea is one they have difficulty in grasping with much explanation, and to simplify by omitting explanation is unsatisfactory. So, too, cross-sections are used to explain mountain building without elucidation, as in Fig. 90, called a valley sliced through. Apart from the careless drawing of the diagram it is likely to remain a queer picture until the pupils' minds are prepared for it. The idea is yet geometric and even grown teachers have considerable trouble in understanding it on first acquaintance. Several pages are devoted to 'Reasons why Philadelphia is a great City,' and after reading them one is inclined to ask: 'Well, why?' The text does not make it clear why

Trenton, for instance, did not take the greater growth.

The geography is constantly connected with history and this is done with much judgment. In describing Turkey a word might have been devoted to the presence of the Turks in Europe. Reference to p. 271 for height of the Spanish plateau (p. 230) fails to obtain information. Manitoba, described in the text is not on any of the maps. Under caravans (p. 234) a good opportunity was passed to show why camels travel in groups. The Manila house, p. 253, should be compared with the similar houses in the West Indies. If the Chinamen in this country are worth mentioning and their exclusion of foreigners from their territory, surely it was in order to note the present restrictions placed on their immigration here by our government. On p. 201 the impression is likely to be obtained that Spanish is spoken in Brazil and at 205 that Lima, eight miles from the Pacific, is an interior city.

The second part of the 'innovation' in this volume is in maps which by their small size allow the volumes to take the handy duodecimo size, 'unimportant names' being excluded. Comparison is challenged in the statement of belief that the 'maps are the best thus far printed in an American geography.'

Now the small size is no innovation of Tarr and McMurry. Professor Davis adopted it two years ago in his 'Physical Geography' and his long teaching of the adequacy of small maps for many purposes is not unknown to his pupils. Some of the maps here are very good indeed but they hardly surpass some of those in the American Book Company's new geographies, while some of the maps in the present volume are unpardonably bad, *e. g.*, the hemispheres, Fig. 119, Europe in Fig. 120, where simplicity of names is attained by representing Europe's chief cities as London, Paris, Berlin, St. Petersburg, Constantinople and Gibraltar (!). The two-page Europe, Fig. 183 has an orography worthy of the middle ages, the Alps being in northern Italy while Pyrenees, Apennines and Carpathians have altogether insignificant relief. The introduction of the map idea by the sketches in Fig. 91 is entirely amiss. The fundamental distinction between pictures and maps is the introduction

of perspective in a picture. But the pretended views of Fig. 91 are not views at all but maps differently colored. The Nova Scotia St. Lawrence view for instance shows no foreshortening with distances, but the same defect is present in the first sketch. It is an attempt to teach by trickery; for being false maps they cannot convey the idea of what a map really is.

Now that the objections have been stated let me hasten to express a hope that the small size geography has come to stay.

The maps of North America, Fig. 123, and the New England States, Fig. 125, seem to me very beautiful maps, but will Brockton and Haverhill agree that Plymouth is more important in New England geography than they? The make-up of the book is attractive, but it should be much revised before being offered to the schools.

The good features of the volume are developed in the admirable *Second Book*, 'North America.' After occupying a quarter of their space with a hastily written account of general physical geography, the authors present a splendid picture of the varied life and industries of different parts of this country, profusely illustrated. This portion of the book is admirable. Where older or briefer books have contented themselves with stating occupations and products, Tarr and McMurray describe industries so vividly and realistically that the interest is absorbing. Professor Tarr's books make 'easy reading,' and this one is no exception. It is to be hoped the use of the volume will be widespread. The teacher's part will be easy. History and industry are both referred to a geographic basis.

Each volume is closed by statistical tables and a pronouncing vocabulary. The latter would be more valuable did it not attempt a closeness of sound reproduction that demands special knowledge of languages and sounds for proper handling. Some inconsistencies and mispronunciations result. Accent and sounds of Spanish words need special revision. *Tuscon* for Tucson is the only misprint noted in the two volumes though a number of errors in the pronunciation are very likely chargeable to the printer. The maps are admirable apart from the hemispheres and Mercator repeated from the First Book.

MARK S. W. JEFFERSON.

Wireless Telegraphy and Hertzian Waves. By S. R. BOTTONE. Whittaker & Co., London. Cloth. Pp. 116. 35 illustrations.

This little book contains a brief account of the phenomena of Hertzian waves and of the development of the system of transmitting signals known as wireless telegraphy. The first chapter is intended for readers who are not familiar with even the more elementary ideas concerning electrical phenomena. The second chapter gives a brief account of the historical development of wireless telegraphy, and the next chapter on Hertzian waves describes in a very simple manner the methods of generating these waves and some of the methods of detecting them, especially those employing the coherer. The chapter on constructional details, which comprises nearly half the book, contains directions for making in an inexpensive way the apparatus required for experiments in the field of wireless telegraphy.

The comparison which the author makes between the action of a coherer and the action of iron filings in a helix through which an electrical current is passing is rather a misleading one, and the impression is given that it is necessary to have the coherer circuit carefully tuned to the transmitting circuit in order to have the coherer respond. Otherwise for a simple presentation of so difficult a subject the book contains very few misleading statements.

F. L. T.

SCIENTIFIC JOURNALS AND ARTICLES.

IN the September number of *The American Journal of Physiology* J. Van Denburgh and O. B. Wright present a carefully prepared account of their experiments 'On the physiological action of the poisonous secretion of the Gila Monster (*Heloderma suspectum*).' They find that the poison is essentially like the various snake venoms in its effects. The rate of respiration, the activity of the heart, the irritability of the sensory apparatus, the rapidity of coagulation of the blood, all suffer first an increase, and later a retardation with a gradual total loss of function. This primary quickening and secondary paralysis is not seen in the vasomotor center; instead, the poison causes immediately a great fall in blood pressure due to

vascular dilatation. The motor nerves are entirely unaffected. The red blood corpuscles are often rendered spherical by the poison, and, outside the body at least, the blood may be laked. The secretion of urine is stopped. Death usually results from respiratory paralysis, though, in case artificial respiration is maintained, death ensues from cardiac failure. Lafayette B. Mendel communicates four brief contributions to physiological chemistry from the Sheffield Laboratory of Yale University. In the first of the papers Professor Mendel gives an analysis of three species of West Indian corals examined for iodine and declares that for many organisms iodine is as essential an element as is chlorine for others. The second paper, 'Glycogen formation after inulin feeding,' by R. Nakaseko, concludes with the statement that for the rabbit at least, the glycogen-forming properties of inulin must still be regarded as uncertain or minimal. G. A. Hanford's work on 'The influence of acids on the amylolytic action of saliva,' shows the impossibility of designating any percentage of acid or alkali which inhibits salivary digestion in a definite degree. The absolute amount of saliva and the attendant variation in the quantity of proteid matter present determine the character of the action. Free hydrochloric acid is certain to cause more or less complete inhibition of salivary action. The fourth contribution, by J. H. Goodman, 'On the connective tissue in muscle' is an account of experiments proving that the substance in muscle connective tissue described by Schepilewsky as mucin, is neither a glycoproteid nor a nucleoproteid, but resembles the *stroma substance* described by J. von Holmgren. B. Moore and W. H. Parker report a study of the effects of complete removal of the mammary glands on the formation of lactose. This research consists of an examination of the urine for sugar during gestation and at the time of parturition after complete extirpation of the mammary glands. If lactose be formed elsewhere than in the mammary glands it should appear in the blood at parturition and hence in the urine. The mammary glands of two goats were removed after several weeks of gestation. Parturition took place normally in both cases

and the urine contained no reducing sugar. The authors believe that lactose is formed in the cells of the mammary gland and not from any intermediate substance carried to the gland by the blood.

DISCUSSION AND CORRESPONDENCE.

THE COPYRIGHT OF UNIVERSITY LECTURES.

TO THE EDITOR OF SCIENCE: In commenting on the decision of the House of Lords in the *Times* v. Lane case, you say (SCIENCE, Aug. 24, p. 319), "Perhaps the lectures given to a class of students, * * * are not made public." On appeal from the Supreme Court of Scotland, this was, however, decided by the House of Lords just fifteen years ago, in the famous case of Caird v. Sime. Sime was a second-hand bookseller in Glasgow, who sold many textbooks to the students of that University. He conceived the idea that he might turn a penny by getting the lectures of Edward Caird, professor of moral philosophy, then the most influential teacher in the University, and publishing them. He did so. The Scotch Courts decided against Caird, but on appeal to the House of Lords the decision was reversed, and a professor or lecturer was held to have his own copyright. It is curious to note, looking to the decision of the Scottish Court in the Caird case, that the minority in the *Times* case in the House of Lords was the Scottish member of the Court of Final Appeal. R. M. WENLEY.

THE INTERNATIONAL PSYCHICAL INSTITUTE.

TO THE EDITOR OF SCIENCE: Observing that my name figures in Bulletin No. 1, July, 1900, of the 'Institut Psychique International' as the member of the Council of Organization for America, I find myself compelled to state publicly that this appearance of my name is unauthorized. WILLIAM JAMES.

NAUHEIM, August 24, 1900.

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

It appears difficult to secure any information in regard to the French Association for the Advancement of Science. We have been unable to get programs by addressing the officers of the

Association, and the French Scientific Journals do not contain any regular announcements or reports of the meetings. The address of the President, General Sebert, before the Paris meeting is, however, published in several journals and the report of the Treasurer is printed in full in the *Revue Scientifique*.

M. Sebert reviewed the progress of mechanical science, and devoted the last third of his address to an international catalogue of scientific literature. It is rather curious that he does not in any way refer to the International Catalogue, but states that the problem is being solved by the Institut International de Biographie, established by MM. Lafontaine and Otlet in Brussels in 1895. The Dewey system of classification is adopted by them, and M. Sebert devotes a considerable part of his address to explaining the system which he advocates in warm terms.

The finances of the French Association are of interest. The capital amounts to 1,326,917 fr., chiefly due to legacies such as the American Association has never received. The income last year was about \$17,000, of which nearly \$7000 was income from the capital and about \$10,000 represented the dues of members. These figures apparently are much more favorable than those of the American Association, in which the income from permanent funds was last year \$233 and receipts from members \$6216. It appears, however, that, owing to the cost of the volume of proceedings and of administration, the expenses of the French Association are considerably larger than the receipts from the annual dues of members, whereas, during the past two years, the American Association has been able to transfer to the permanent funds a portion of the dues received from members.

Although about half of the interest on the capital is used for current expenses, there is still a considerable sum—about \$3000—which is annually awarded for the promotion of research. Among the larger grants made last year were: \$300 to M. Giard for the publication of papers from the laboratory at Wimereux; \$300 to M. Deniker for the publication of his book on the races of Europe; \$240 to M. Lacaze-Duthiers towards repairing the steam-

boat of the zoological laboratory at Arago, and \$200 to M. Turpain for researches in telegraphy by Hertzian waves.

THE ELECTRICAL EFFECTS OF LIGHT UPON GREEN LEAVES.*

IN the preliminary communication recently made to the Royal Society, the author shows how, from the study of the electrical effects of light upon the retina, he was led to ask whether the chemical changes aroused by the action of light upon green leaves are also accompanied by electrical effects demonstrable in the same way as the eye currents. The question is tested in the following way: A young leaf freshly gathered is laid upon a glass plate and connected with a galvanometer by means of two unpolarizable clay electrodes *A* and *B*. The half of the leaf connected with *A* is shaded by a piece of black paper. An inverted glass jar forms a moist chamber to leaf and electrodes, which are then enclosed in a box provided with a shuttered aperture through which light can be directed. A water trough in the path of the light serves to cut out heat more or less. Under favorable conditions there is obtained with such an arrangement a true electrical response to light, consisting in the establishment of a potential difference between illuminated and non-illuminated half of a leaf, amounting to 0.02 volt.

The deflection of the galvanometer spot during illumination is such as to indicate current in the leaf from excited to protected part. The deflection begins and ends sharply with the beginning and end of illumination; it is provoked slightly by diffuse daylight, more by an electric arc-light, most by bright sunlight. It is abolished by boiling the leaf, and by the action of an anæsthetic, carbon dioxide.

The first experiments, made at the end of March, were upon iris leaves taken from plants about six inches high, and the response to light was then between 0.001 and 0.002 volt in value. Experiments upon similar leaves were resumed early in May, when it appeared that the external condition in which the state of the leaf is

* Abstract of a paper presented before the Royal Society by Augustus D. Waller, M.D., F.R.S., and published in *Nature*.

most obviously governed is *temperature*. On warm days the response ranged from 0.005 to 0.02 volt; on cold days it did not rise above 0.005, and was sometimes *nil*. Some tests upon leaves in a warmed box gave satisfactory results, which may thus be summed up: The normal response at 15°–20° C. is diminished or abolished at low temperature (10°) augmented at high temperature (30°), diminished at higher temperature (50°), and abolished by boiling.

As the month of May advanced, the iris leaves, even in the warm box, became more and more inert, and by the 23d inst., when the plants were mostly full grown and in flower, no satisfactory leaf could be found. Leaves of iris appear to give more marked response at or about mid-day, than at or about 6 p. m. Tested by Sach's method the leaves give no evidence of starch activity during isolation.

On the failure of the iris leaves to react, other leaves were sought for which should give evident differences of reaction in correlation with evident differences of state. Leaves of *tropæolum* and of *mathiola* gave a response to light contrary in the main to the ordinary iris response, viz, 'positive' during illumination, and subsequently 'negative.' In these two cases leaves empty of starch acted better than leaves laden with starch. Leaves of *begonia* gave a variety of responses strongly suggestive of the simultaneous action of two opposed forces effecting a resultant deflection in a + or — direction. Leaves of ordinary garden shrubs and trees, etc., *e. g.*, lilac, pear, almond, mulberry, vine, ivy, gave no distinct response; this is possibly due to a lower average metabolism in such leaves as compared with the activity of leaves of small young plants in which leaf-functions are presumably concentrated within a smaller area. The petals of flowers gave no distinct response, which indicates that chloroplasts are essential to the reaction.

The effect of carbon dioxide upon the iris leaf was abolition of response during and after passage of the gas, with subsequent augmentation. Upon *mathiola* and *tropæolum*, augmentation of response followed on applying air containing 1 to 3 per 100 of carbon dioxide, and prompt abolition resulted from a full stream run through the leaf-chamber. On the air

supply being kept clear of carbon dioxide there was gradual abolition of response, followed by gradual recovery on the re-admission of a small amount of carbon dioxide.

'Fatigue' effects may be produced if the successive illuminations (of five minutes duration) are repeated at short intervals (10 minutes). At intervals of one hour, successive illuminations of five minutes produce approximately equal effects. With the leaf of *mathiola*, periods of illumination of two minutes at intervals of 15 minutes were used without provoking any obvious sign of fatigue.

SCIENCE RESEARCH SCHOLARSHIPS.

THE Commissioners for the Exhibition of 1851, as we learn from the *London Times*, have made the following appointments to Science Research Scholarships for the year 1900 on the recommendation of the authorities of the respective universities and colleges. The scholarships are of the value of £150 a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result in work of scientific importance.

Nominating Institution.	Scholar.
University of Edinburgh . .	Charles E. Fawsitt, B.Sc.
University of Glasgow	Vincent J. Blyth, M.A.
University of Aberdeen	James Moir, M.A., B.Sc.
Yorkshire College, Leeds . . .	William M. Varley, B.Sc.
University Coll., Liverpool . .	John C. W. Humfrey, B.Sc.
University College, London . .	Samuel Smiles, B.Sc.
Owens College, Manchester . .	Norman Smith, B.Sc.
Univ. Coll., Nottingham	Lorenzo L. Lloyd.
Univ. Coll. of South Wales and Monmouthshire, Car- diff	
Royal Coll. Science, Dublin . .	Alice L. Embleton, B.Sc.
Queen's College, Galway	John A. Cunningham, B.A.
University of Toronto	William S. Mills, B.A.
Queens University, Kings- ton, Ontario	John Patterson, B.A.
Dalhousie University, Hal- ifax, Nova Scotia	William C. Baker, A.M.
University of Sydney	James Barnes, M.A.
	John J. E. Durack, B.A.

The following scholarships granted in 1898 and 1899 have been continued for a second year

on receipt of a satisfactory report of work done during the first year :

Nominating Institution.	Scholar.	Place of Study.
Univ. St. Andrews.	J. C. Irvine, B.Sc.	Univ. of Leipzig.
Mason Univ. Coll., Birmingham.	Henry L. Heathcote, B.Sc.	Univ. of Leipzig.
Univ. Coll., Bristol.	Winif. E. Walker, B.Sc.	Univ. Coll., London.
Yorkshire College, Leeds.	Fred. W. Skirrow, B.Sc.	Univ. of Leipzig.
Univ. Coll., Liverpool.	Charles G. Barkla, B.Sc.	Cavendish Lab., Cambridge.
Univ. Coll., London	Harriette Chick, B.Sc.	Thompson-Yates Lab., Univ. Coll., Liverpool.
Owens Coll., Manchester.	Frank A. Liddbury, B.Sc.	Univ. of Leipzig.
Durham Coll. Sci., Newcastle-upon-Tyne.	William Campbell, B.Sc.	Royal Coll. of Sci., S. Kensington.
Univ. Coll., Nottingham.	Louis Lownds, B.Sc.	Univ. of Berlin.
Univ. Coll. Wales, Aberystwith.	James T. Jenkins, B.Sc.	Univ. of Kiel and Biol. Institution, Heligoland.
Univ. Coll. of North Wales, Bangor.	Robert D. Abell, B.Sc.	Univ. of Leipzig.
Queens Coll., Belfast.	William Caldwell, B.A.	Univ. Würzburg.
McGill Univ., Montreal.	William B. McLean, B.Sc.	Owens Coll., Manchester.
Univ. of Melbourne	Bertram D. Steele, B.Sc.	Univ. of Breslau.
Queen's Coll., Cork.	Ed. J. Butler, M.B.	Univ. of Freiburg.
Univ. of New Zealand.	Joseph W. Mellor, B. c.	Owens Coll., Manchester.
Univ. Coll., London	Louis N. G. Filon, M.A.	King's Coll., Cambridge.

The following scholarships granted in 1898 have been exceptionally renewed for a third year :

Nominating Institution.	Scholar.	Place of Study.
Mason Univ. Coll., Birmingham.	A. H. H. Buller, B.Sc., Ph.D.	Univ. of Munich.
Yorkshire College, Leeds.	Harry T. Calvert, B.Sc.	Univ. of Leipzig.
Royal Coll. of Sci., Dublin.	Rob. L. Wills, B.A.	Cavendish Lab., Cambridge.
Dalhousie Univ., Halifax, N. S.	Eben. H. Archibald, M.Sc.	Harvard Univ.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR A. MICHELSON, of the University of Chicago, has been awarded the grand prize of the Paris Exposition for his Echelon spectro-scope.

It is reported that Professor Haeckel, of Jena, is about to start for Java to conduct explorations in search of *Pithecanthropus erectus*.

In the matter of the vacancy arising from the death of Professor James E. Keeler, the president and board of regents of the University of California have authorized astronomer W. W.

Campbell to discharge the duties of the director of the Lick Observatory, *ad interim*.

M. M. OUSTALET and DEPOUSARQUES have been nominated by the Paris Academy of Sciences for the chair of zoology in the Muséum d'Histoire naturelle, rendered vacant by the death of Professor Milne-Edwards. One of these candidates will be selected by the minister of public instruction.

MR. THOMAS LARGE has been appointed assistant in charge of the Fresh Water Biological Station of the University of Illinois, at Meredosia, Illinois, to succeed Dr. C. A. Kofoid, who, as we have already announced, has accepted a call to the University of California.

MR. J. STIRLING, Government geologist of Victoria, is at present in London, and will address several scientific societies during his stay in England.

SURGEON A. R. THOMAS of the U. S. Marine Hospital Service has been sent to Glasgow to investigate the bubonic plague which appears to be increasing in that city.

THE Government of Queensland has engaged Dr. Maxwell, the sugar expert of Honolulu, for five years' service on the Food Commission at a salary of \$20,000 a year.

DR. F. ROEMER, assistant in the Zoological Institute at Breslau, has been made curator in the Senckenbergischen Museum at Frankfurt-on-the-Main.

PROFESSOR K. LAMPERT, of Stuttgart, has been made curator of the Royal Natural History collections.

DR. D. MORRIS, the British Commissioner of Agriculture for the West Indies, is at present in Great Britain for the purpose of reporting to the Colonial office.

DR. C. VIRCHOW has been appointed chemist in the geological bureau at Berlin.

THE tomb of Sir Humphrey Davy, at Geneva, which for some years was in a neglected state, has recently been renovated.

DR. JOHN ANDERSON, M.D., F.R.S., has died at Buxton at the age of 66 years. He was appointed superintendent of the Indian Museum, Calcutta, in 1865, and made several expeditions to China. He was the author of

numerous and important contributions to zoology and the literature of scientific explorations.

WE regret to learn of the death of Professor Henry Sidgwick, who was recently compelled by ill health to resign the professorship of moral philosophy at Cambridge University. Professor Sidgwick was born in Yorkshire on May 31, 1838, and was educated at Rugby and Trinity College. He was elected a fellow of Trinity College, but resigned owing to the religious tests then imposed. He was, however, elected an honorary fellow of Trinity in 1881, and in 1883 became Knightbridge professor of moral philosophy. Professor Sidgwick published numerous and important books on ethical and economic subjects which united in a rare degree genius and scientific caution.

FRIEDRICH WILHELM NIETZSCHE, the philosopher and man of letters, died on August 25th at Weimar, where for eleven years he had been living hopelessly insane at the home of his sister. Nietzsche was formerly professor of oriental languages at Basle, but later gave this up to travel and to write his remarkable books which showed genius of a destructive rather than of a constructive character. They are of interest to men of science, because he was greatly influenced by modern theories of biological evolution.

THE death is announced of Sir John Bennett Lawes, F.R.S., at the age of 86 years. He was educated at Eton and Oxford, and early began the study of scientific agriculture, being one of the first to use bone dressing and artificial fertilizers. He was the author of over one hundred papers on the scientific aspects of agriculture.

SIR MALCOLM FRASER, a civil engineer, formerly Surveyor-general and Colonial Secretary of Western Australia, died at Clifton on August 17th, aged 66 years.

THE Fourth International Congress of Psychology opened at Paris on August 20th with an attendance of about 400 and a long list of papers on its program. The first general addresses were given by M. Ribot, professor in the Collège de France and Professor Ebbinghaus of Breslau. Among the Americans in

attendance were Professor Ladd of Yale University, Professor Münsterberg of Harvard University, Professor Bryan of the University of Indiana, and Professor Warren of Princeton University.

THE annual meeting of the English Arboricultural Society, says *Nature*, was held at Manchester recently. Professor Somerville was appointed president for the ensuing year. Reports were read from the judges upon essays on 'Foreign *versus* Native Timber,' 'Agricultural and Woodland Drainage,' and 'Thinning.' The silver medal for the first essay was awarded to Mr. George Cadell, late of the Indian Forest Department, and bronze medals for the other essays were given to Mr. D. A. Glen, of Kirby, near Liverpool, and Mr. A. Dean, of Egham.

THE Governing Body of the Jenner Institute announce their intention of awarding three studentships of £150 each, tenable by British subjects for one year from January 1st next, and renewable for a second year at the option of the Governing Body, for the purposes of research at the Institute. Applications from candidates must be sent in by November 1st.

THE Berlin Academy of Sciences offers its prize on the Steiner foundation for the solution of some important problem connected with the theory of curved surfaces, preferably related to the work of Steiner. The prize is of the value of 4000 Marks with a second prize of 2000 Marks. The paper must be handed in by the end of the year 1904, and may be written in English.

MAJOR GIBBONS has reached Omdurman after a trip through Africa extending to about 13,000 miles. Among the objects attained were the mapping of Marotseland, 200,000 miles in area; the accomplishment of the first steam navigation of the Middle Zambesi, and the tracing of the whole course of the river, the discovery of its source and the determination of its watershed. Thence the route of the expedition was eastward and by way of the Great Lakes to the Nile. It is understood that Major Gibbons has brought with him valuable collections.

DURING the summer the Ohio State Archaeological and Historical Society, under the direction of the curator, Wm. C. Mills, carried on

explorations at the Baum prehistoric village site, near Bourneville, Ross County, Ohio. The work was very successful; more than 60 skeletons were found and photographed in place. This village site is especially rich in fine implements of bone, shell and stone, of which several thousand were taken from the ash pits together with the bones of the elk, deer, bear, wolf, raccoon, wild turkey and Indian dog.

THE French Minister of War, as we learn from *Nature*, has invited the Paris Academy of Sciences to advise as to the precautions to be adopted in selecting and planting trees in the neighborhood of powder magazines, in order to secure the best protection from lightning.

THE United States Civil Service Commission announces that it has been informed by the Department of Agriculture that there is an opportunity at this time for appointment to two or three positions in the office of Public Road Inquiries of persons qualified as practical road builders and who have a knowledge of rural engineering, geology, mineralogy, and kindred subjects. Persons who desire to become eligible will not be required to appear at any place for examination but should file with the Commission a properly certified statement as to the length of time spent in college, the studies pursued, the standing in those studies, and the special qualifications they have for such work mentioned above together with a thesis upon the subject mentioned, or in lieu of this thesis literature upon this subject published over their own signatures. At the request of the Department applications will not be accepted from other than graduates of colleges receiving the benefits of grants of land or money from the United States. The length of time any scientific aid may serve in the Department is limited to two years. The salary shall not exceed \$40 per month. The subjects and weights of this examination will be as follows:

Subjects.	Weights.
1. College course with bachelor's degree.....	50
2. Post-graduate course and special qualifications.....	25
3. Thesis or other literature.....	25
Total	100

A REMARKABLE meteor is reported by observers in New England. As seen from the mouth of the Damariscotta River, Maine, its altitude, when, at 8 P. M., it burst into view, was about thirty degrees and its direction north by west, color a rich copper green, and magnitude and brilliancy so great as to light up the whole country with a flash of great intensity, the light persisting about two seconds before final extinction. The mass was pear-shaped, larger end downward. The smaller end shaded from green to yellow. A little later, a bright red meteorite was seen north by west of smaller size. We hope that our correspondents will supply more precise data.

DETAILS have been published in regard to the plague at Hong-Kong which show that the epidemic has not been quite so severe this year as last, and is now abating somewhat. The deaths during the past six years have varied in a curious way, being as follows: 1894, 2485, 1895, 36; 1896, 1078; 1897, 19; 1898, 1175; 1899, 1428. The deaths are chiefly among the Chinese, the mortality being excessive—perhaps in part due to the fact that cases which did not result fatally were not reported. Last year the total number of cases was 1455, and the number of deaths 1407.

THE fastest regular trains in the world are, as we have already noted, those running over the Philadelphia and Reading and Pennsylvania Railroad from Camden to Atlantic City. By the former line the 55½ miles is traversed at the rate of 66.6 per hour. The Empire State Express, of the New York Central Railroad, however, no longer holds the record for long distance trains. It runs from New York to Buffalo—440 miles—at the rate of 53.33 miles per hour. The Sud Express on the Orleans and Midi Railway now runs from Paris to Bayonne, a distance of 486½ miles, at the rate of 54.13 miles per hour.

THE London *Daily Graphic*, as quoted in *Nature*, states that the Norwegian government has built and fitted out a steam vessel for the express purpose of marine scientific research, and has placed her, as well as a trained staff of assistants, in charge of Dr. J. Hjort as leader of the Norwegian Fishery and Marine Investi-

gations. The vessel herself, the *Michael Sars*, has been constructed in Norway on the lines of an English steam trawler—that type of boat being regarded as the most seaworthy and suitable for such an expedition—but considerably larger, being 132 feet in length, 23 feet beam, and fitted with triple expansion engines of 300 horse-power. The fishing gear includes, *inter alia*, trawls, nets, and lines of all kinds, with massive steel hawsers and powerful steam winches to work the heavy apparatus, while the numerous scientific instruments are of the very best and latest description. The expedition left Christiana in the middle of July, on what may be termed its trial trip along the Norwegian coast (accompanied for part of the time by Dr. Nansen, who was desirous of testing various instruments in which he had made improvements), and has just sailed from Tromsø on a lengthy cruise to the North Atlantic and Arctic Oceans. Dr. Hjort has already added so much to the knowledge of pelagic fishes, their life, habits, and the causes affecting their migrations, that, with the means now at his disposal, a considerable amount of valuable information will probably be gained which will prove of service to the fishing industry of all nations.

THE Queen Regent of Spain has signed a decree establishing the method of accounting time in the kingdom as follows:

(1) In all railway, mail (including telegraph), telephone, and steamship service in the Peninsula and the Balearic Islands, and in all the ministerial offices, the courts, and all public works, time shall be regulated by the time of the Greenwich Observatory, commonly known as western European time.

(2) The computation of the hours in the above-mentioned services will be made from the hour of midnight to the following midnight in hours from 1 to 24, omitting the words *tarde* (afternoon) and *noche* (night), heretofore in customary use.

(3) The hour of midnight will be designated as 24.

(4) The interval, for instance, between midnight (24) and 1 o'clock will be designated as 0.05, 0.10, 0.59.

THE report of the Zoological Gardens of Ghizeh, near Cairo, for the year 1899 is summarized in *Nature*. Under its present director, Captain Stanley Flower, it has become a popular place of resort for the European visitors to

Egypt, as well as for the Cairenes. The receipts for 1899 were 3033*l.*, of which 968*l.* were for gate-entrances, and the expenditure was 3019*l.* The list of donors includes many well-known names, amongst them those of Sir William Garstin, Prince Omar Tousson, Sir F. Wingate and Lord Kitchener. The government of India presented an elephant. Various new buildings were erected, and others were reconstructed in 1899. The number of animals in the collection on October 1st of that year was 473, against 270 at the corresponding date in 1898. A list of wild birds that inhabit the Ghizeh Gardens, and in many cases breed there, enumerates nineteen species, amongst which is the European song-thrush (*Turdus musicus*). Two proboscis monkeys (*Nasalis larvatus*), presented by the government of the Netherlands, East Indies, unfortunately did not live long. Since the report was issued Captain Flower has succeeded in bringing to the Ghizeh Gardens from the Sudan a fine young giraffe, presented by the Sirdar.

A CORRESPONDENT writes to the *London Times*: At this week's meeting of the Royal Horticultural Society a fruit was exhibited for the first time which bids fair to become very useful. From a botanical point of view also it is of considerable interest, the plant bearing it being a hybrid between the raspberry and the common blackberry. As the 'Mahdi,' as it has been called, was raised by Messrs. Veitch, its origin is well authenticated, the seed parent being a variety of the raspberry known as 'Belle de Fontenay.' The same cannot be said for the Logan berry trailing from the other side of the Atlantic, for which a somewhat similar parentage has been claimed. A high authority, however, is of opinion that the raspberry plays no part in its composition, and that both its parents were an American species of *Rubus* instead of only one. The 'Mahdi' has very much the habit of the blackberry, and in cultivation it is trained in the same way. Its fruit recalls to some extent the dewberry of our hedges. There is the same bloom, but the number of fruitlets is greater. Careful scrutiny will reveal many intermediate characters; the taste of the 'berry' combines a preponderant flavor of the dewberry with a

suspicion of that of the raspberry. Most important is the time of fruiting as regards the future of the plant economically, for it comes into bearing as the raspberries are failing and before the blackberries are ripe. The 'Mahdi' is very prolific and has considerable claims to be a decorative plant; it will not, however, be placed upon the market for probably another twelve months at least.

A SUMMARY of the work done by the Reichsanstalt from February, 1899, to February, 1900, has been published in the *Zeitschrift für Instrumentenkunde*. According to an abstract in the *Electrical World* the comparison of the two sets of standard resistance coils showed good agreement; the variations during seven years amount only to a few hundred thousandths of the original value. Preliminary experiments were made for determining the capacity of an air condenser. A greater number of zinc and cadmium standard cells were made for testing purposes; renewed measurements gave results in good agreement with the figures published last year. The exact investigation of the conductivity of aqueous solutions has been concluded for the chlorides and nitrates of alkaline metals. The instruments, storage batteries, primary cells, cut-outs, insulating and conducting materials, arc lamp carbons, fuses which have been tested, are given in a table. Statistical material on the use of electric meters in practice has been collected; according to the information given by the central stations, about 60,000 meters are at present in use in Germany, while about twice as many is the number estimated by the manufacturers. The apparatus for testing alternating current instruments was completed. A new resistance material of Heraeus was tested, the investigation of the resistance devised by Kundt was continued. One hundred and eleven Clark and 22 Weston cells were tested. The variation from the normal e. m. f. was below 0.0003 volt for 83 Clark cells, between 0.0004 and 0.0006 volt for 23 cells, 0.001 volt for 1 cell and greater than 0.001 volt for 4 cells. The agreement of the commercial Weston cells was found to be very satisfactory. The magnetic properties of 25 samples of steel and iron were tested. An investigation was made of the dif-

ference between continuous and interrupted magnetization. Also preliminary measurements were made to investigate the influence of repeated annealing upon the magnetic properties of different samples of iron.

SOME of our Consuls in South America, says the *London Times*, refer in their last reports to the virtues ascribed to the tea made from yerba maté, a herb which takes the place to some extent of tea and coffee, and which is derived from the leaves of the *Ilex Paraguariensis*, a tree of from twelve to twenty feet in height. The Consul in Paraguay says this tea is consumed by a large proportion of the populations of Brazil, the Argentine, Uruguay, Chili and Paraguay. The leaves are gathered every two or three years and dried over a slow fire; they are then pounded in mortars in the ground, and finally packed in fresh skins and dried in the sun. The tea is made by pouring boiling water on the leaves, which serve for several infusions. The taste is bitter, but not unpleasant, and the effects are asserted to be invigorating. It is said that it would be valuable as a restorative to troops on the march and on active service, and the French Government have ordered a shipment of maté for the colonial troops and some samples have also been sent to Germany for experimental purposes. An attempt is also being made to introduce it into the United States as a suitable beverage for the working classes. When analyzed the tea is shown to contain caffeine and cafetannic acid in important proportions. The Council-General at Rio also refers to the subject as one of commercial interest. It is claimed, he says, on behalf of the tea that it possesses superior stomachic properties to tea and coffee, in that, while it is refreshing and invigorating and favorable alike to mental and physical exertion, it does not disturb the nervous system. But even Brazilians are not agreed as to its merits, some alleging that by its aid the most arduous work can be done, such as forced marches of troops on short rations; others asserting that in war coffee has proved much more sustaining. However this may be, it is largely consumed in South American countries when the prices of low grade China teas are too high to admit of their shipment to South

America, and it is therefore possible that it has some good qualities to recommend it.

THE South African Native Races Committee have, as we learn from the *London Times*, addressed a letter to the Colonial Secretary submitting certain points for his consideration on which they believe that there is need for an inquiry connected with the black and colored population of South Africa. It is stated that no recent public investigation into this subject has been made. Even with regard to Cape Colony and Natal the time seems to have come for further inquiry with reference to many points of importance, such as the overcrowding of locations; the provision of land for surplus population; the practical effect of the Glen Grey act; the working of the Pass Laws; the question of native education, and other matters. In other parts of British South Africa the need for a thorough investigation of native questions is still greater. The committee urge on her majesty's government the expediency of inquiries being instituted at as early a date as possible, with regard to some at least of the following matters: (1) Laws, customs, and land tenure of the natives in districts which were not the subject of examination by the Cape Government Commission; (2) the operation of the existing tribal system, and the expediency of maintaining it; (3) the advisability of setting aside large areas (such as the whole or part of the Zoutpansberg district and Swaziland) to be administered for the exclusive use and benefit of the native tribes; (4) the condition of existing native locations and reserves, the terms upon which lands are secured to the natives, and the need and method of providing further lands for the surplus native population; (5) the provision of further facilities for the flow of labor to centers of industry, and, if practicable, for the migration of families to such centers, the supervision of contracts of service, the securing of safe and healthy conditions of labor in the mines and other occupations; (6) the provision of advice and assistance for natives at industrial centers, and of facilities for the deposit and transmission of their earnings; (7) the need for further Government aid for native education and for reforms in the present system; (8) the effects of existing

methods of taxation on the economic and social condition of the natives; (9) the working of the Pass Laws, with a view to ascertaining whether their mitigation or abolition is practicable; (10) the administration of the Liquor Laws.

UNIVERSITY AND EDUCATIONAL NEWS.

THE fact that under the new constitution of the University of London the registered graduates have a larger share than before in the government of the University has led to the formation of the University of London Graduates Union. Dr. K. P. H. Pye-Smith, F.R.S., has been elected president.

PRESIDENT CHARLES F. THWING, of Western Reserve University, Cleveland, is at present delivering a course of lectures at the University of Virginia on 'The American University,' treating its organization and administration, its chief executive, the university and patriotism, and the place of the university in American life.

DR. GEORGE P. DREYER, Ph.D. (Johns Hopkins), associate professor of physiology in the Johns Hopkins Medical School, has been elected professor in charge of the physiological department of the College of Physicians and Surgeons (Chicago), the medical department of the University of Illinois.

THE vacancy in the chair of mathematics in Haverford College caused by the removal of Dr. Frank Morley to Johns Hopkins University has been filled by the appointment of Dr. A. W. Reid, A.B. (Johns Hopkins) Ph.D. (Göttingen), instructor in mathematics at Princeton University. The vacancy at Princeton has been filled by the appointment of Dr. L. P. Eisenhart who received this year the doctorate at the Johns Hopkins University.

DR. TH. ZIEHEN, associate professor of psychiatry in the university at Jena, has been appointed professor in the University of Utrecht.

WE notice also the following appointments in foreign universities: Dr. Pfeiffer professor of agricultural chemistry in the university at Jena has been called to Breslau; Professor P. Curie, of Paris, has been appointed professor of general and experimental physics in the University at Geneva; Dr. Zehander, has qualified as docent in physics in the university at Munich.